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(54) **OPTIMIZED CONSUMPTION OF  
THIRD-PARTY WEB SERVICES IN A  
COMPOSITE SERVICE**

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(56) **References Cited**

**U.S. PATENT DOCUMENTS**

6,816,907	B1	11/2004	Mei et al.	
6,950,848	B1	9/2005	Yousefi'zadeh	
7,062,559	B2	6/2006	Yoshimura et al.	
7,162,436	B1	1/2007	Eckel, Jr.	
7,194,522	B1	3/2007	Swildens et al.	
7,269,157	B2	9/2007	Klinker et al.	
7,310,684	B2	12/2007	Patrick et al.	
7,552,170	B2 *	6/2009	Owen et al.	709/203
7,743,001	B1 *	6/2010	Vermeulen et al.	705/400

7,783,499	B2 *	8/2010	Boughannam	705/1.1
7,986,707	B2 *	7/2011	Dettori et al.	370/423
8,380,845	B2	2/2013	Mercuri	
2002/0194324	A1	12/2002	Guha	
2003/0061365	A1	3/2003	White et al.	
2003/0115149	A1 *	6/2003	Dan et al.	705/64
2003/0131073	A1	7/2003	Lucovsky et al.	
2003/0149735	A1	8/2003	Stark et al.	
2004/0064529	A1 *	4/2004	Meredith et al.	709/219
2005/0034001	A1	2/2005	Pontarelli	
2005/0038867	A1 *	2/2005	Henderson et al.	709/217
2005/0086330	A1 *	4/2005	Perham et al.	709/220
2005/0172027	A1 *	8/2005	Castellanos et al.	709/229
2005/0241823	A1	11/2005	Sarikivi	
2006/0080120	A1	4/2006	Tcherevik	
2006/0161554	A1	7/2006	Lucovsky et al.	

(Continued)

**OTHER PUBLICATIONS**

U.S. Notice of Allowance dated Oct. 15, 2012 in U.S. Appl. No.  
12/900,481.

(Continued)

*Primary Examiner* — Glenton B Burgess

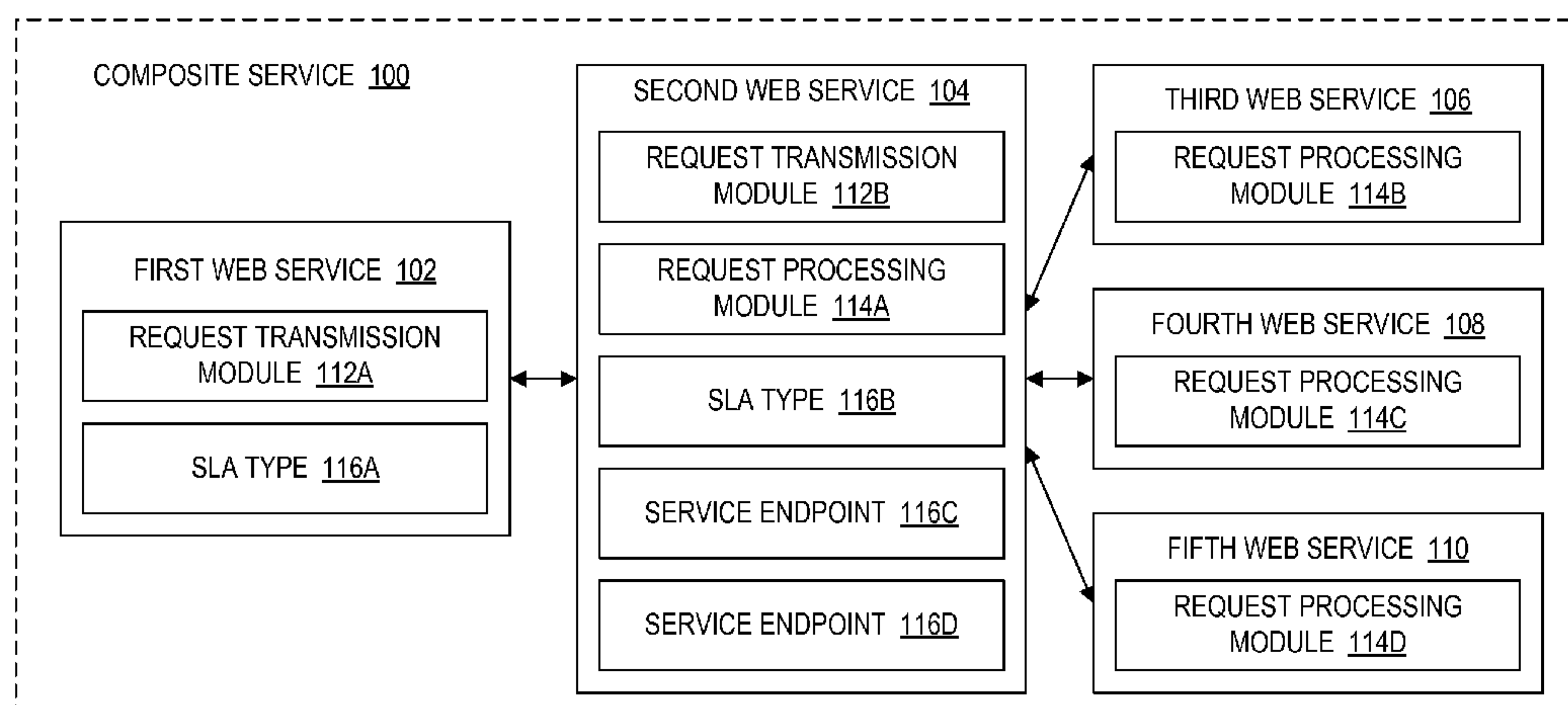
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(57) **ABSTRACT**

Technologies are described herein for routing a service request to an appropriate web service. A first service request is routed from a first web service to a second web service. Routing factors associated with the second web service are monitored. A determination is made as to whether the routing factors indicate that the second web service is no longer appropriate for handling service requests. If the routing factors indicate that the first web service is no longer appropriate for handling service requests, then a second service request is routed from the first web service to a third web service. The first web service, the second web service, and the third web service are included in a composite service.

**18 Claims, 3 Drawing Sheets**





(56)

**References Cited**

## U.S. PATENT DOCUMENTS

2006/0224748	A1	10/2006	Gupta et al.	
2007/0005777	A1 *	1/2007	Fremantle et al.	709/228
2007/0156813	A1	7/2007	Galvez et al.	
2007/0156919	A1	7/2007	Potti et al.	
2007/0256083	A1 *	11/2007	Vayssiere	719/320
2008/0080396	A1	4/2008	Meijer et al.	
2008/0080552	A1	4/2008	Gates et al.	
2008/0082693	A1	4/2008	Meijer et al.	
2008/0104393	A1	5/2008	Glasser et al.	
2008/0134043	A1	6/2008	Georgis et al.	
2008/0189243	A1	8/2008	Li et al.	
2008/0235384	A1	9/2008	Meek et al.	
2008/0320497	A1	12/2008	Tarkoma et al.	
2009/0006614	A1	1/2009	Le et al.	
2009/0037896	A1 *	2/2009	Grechanik et al.	717/168
2009/0048994	A1	2/2009	Applebaum et al.	
2009/0150565	A1	6/2009	Grossner et al.	
2009/0157419	A1	6/2009	Bursey	
2009/0182955	A1	7/2009	Cherukuri	
2009/0196308	A1	8/2009	Pan et al.	
2009/0210528	A1	8/2009	Swildens et al.	
2009/0248693	A1	10/2009	Sagar et al.	
2010/0030866	A1	2/2010	Bedi	
2010/0076856	A1	3/2010	Mullins et al.	
2010/0088150	A1	4/2010	Mazhar et al.	
2010/0131324	A1 *	5/2010	Ferris	705/8
2010/0131649	A1	5/2010	Ferris	
2010/0153482	A1	6/2010	Kim et al.	
2010/0211782	A1	8/2010	Auradkar et al.	
2010/0299763	A1	11/2010	Marcus et al.	
2011/0231899	A1	9/2011	Pulier et al.	
2011/0238459	A1	9/2011	Bottom	
2011/0276490	A1	11/2011	Wang et al.	
2011/0296022	A1	12/2011	Ferris et al.	
2012/0023501	A1	1/2012	Chi et al.	
2012/0066487	A1	3/2012	Brown et al.	
2012/0079490	A1	3/2012	Bond et al.	
2012/0124193	A1	5/2012	Ebrahim et al.	

## OTHER PUBLICATIONS

U.S. Official Action dated Nov. 21, 2012 in U.S. Appl. No. 12/901,591.

U.S. Official Action dated Nov. 14, 2012 in U.S. Appl. No. 12/907,996.

“Amazon Elastic Compute Cloud (Amazon EC2)”, Retrieved Jul. 25, 2010 from <http://aws.amazon.com/ec2/>, 13 Pages.

“Best Ever Cloud-based Monitoring Service Unveiled”, May 31, 2010, Retrieved from <http://news.znetindia.com/best-ever-cloud-based-monitoring-service-unveiled.html>, 4 pgs.

“Cloud Services: Deploy websites, servers and storage on-demand. Only pay for what you need”, Retrieved Jul. 25, 2010 from <http://tier3.com/cloud-services>, 1 pg.

“Microsoft Windows Azure Cloud Computing Service”, Retrieved Aug. 20, 2010 from <http://www.itstrategists.com/Microsoft-Azure.aspx>, 1 pg.

“Windows Azure platform”, Retrieved Jul. 25, 2010 from <http://www.microsoft.com/windowsazure/>, 2 pgs.

Braynard, et al., “Opus: an Overlay Peer Utility Service”, Aug. 7, 2002, IEEE Proceedings Open Architectures and Network Programming, pp. 167-178.

Buyya et al., “Market-Oriented Cloud Computing: Vision, Hype, and Reality for Delivering IT Services as Computing Utilities”, Sep.

25-27, 2008, Proceedings of the 10th IEEE International Conference on High Performance Computing and Communications, HPCC, 9 pgs.

Buyya et al., “Service and Utility Oriented Distributed Computing Systems: Challenges and Opportunities for Modeling and Simulation Communities”, Apr. 13-16, 2008, Proceedings of the 41th Annual Simulation Symposium, (ANSS-41), pp. 68-81.

Chandra et al., “Dynamic Resource Allocation for Shared Data Centers Using Online Measurements,” 2002, Technical Report, TR02-30, Department of Computer Science, 22 pgs.

Clayman, et al., “Monitoring Service Clouds in the Future Internet”, 2010, *Towards the Future Internet*. G. Tselentis et al. (Eds.), IOS Press, p. 115-126.

Fankhauser, et al., “Service Level Agreement Trading for the Differentiated Services Architecture”, Nov. 1999, Swiss Federal Institute of Technology, Computer Engineering and Networks Lab, Technical Report, No. 59, 17 pgs.

Franceschini, et al., “Cloud Computing: An Agile Approach to IT”, Retrieved Aug. 3, 2010 from <http://www.hds.com/assets/pdf/cloud-computing-an-agile-approach-to-it.pdf>, 20 pgs.

Hassidim, “Cloud Tools Command Line Framework”, Retrieved Aug. 20, 2010 from <http://www.gigaspace.com/wiki/display/CCF/Cloud+Tools+Command+Line+Framework>, 7 pgs.

Leung, “Cloud Monitoring Services: A Resource Guide,” Feb. 4, 2010, Retrieved at <http://www.datacenterknowledge.com/archives/2010/02/04/cloud-monitoring-services-a-resource-guide/>, 12 pgs.

Loh, “Automating Cloud Services”, Nov. 12, 2009, Retrieved from [http://www.tapinsystems.com/downloads/Automating\\_Cloud\\_Services.pdf](http://www.tapinsystems.com/downloads/Automating_Cloud_Services.pdf), 14 pgs.

Marko, “Cloud Applications: What’s Ready?—Cloud Computing Tiers”, Feb. 26, 2010, Processor, vol. 32 No. 5, 4 pgs.

Parameswaran et al., “Cloud Interoperability and Standardization”, 2009, SETLabs Briefings, vol. 7, No. 7, pp. 19-27.

Partho, “Top10 Cloud Computing Service Providers in 2010: #8.Go Grid”, May 21, 2010, Retrieved from <http://blog.taragana.com/index.php/archive/top-10-cloud-computing-service-providers-in-2010/>, 8 pgs.

Taft, “CSC to Resell Microsoft Cloud Services”, Jul. 5, 2009, Retrieved from <http://www.devsource.com/c/a/Architecture/CSC-to-Resell-Microsoft-Cloud-Services/>, 2 pgs.

“WebMethods X”, Retrieved at << [http://www.softwareag.com/fr/images/SAG\\_XBroker\\_FS\\_Dec07-web\\_tcm46-33852.pdf](http://www.softwareag.com/fr/images/SAG_XBroker_FS_Dec07-web_tcm46-33852.pdf) >>, Dec. 2007, pp. 2.

“SOA Software”, Retrieved at << <http://www.soa.com/solutions/faqs/> >>, Jul. 26, 2010, pp. 7.

Mitra, Tilak, “Architecture in practice, Part 5: SOA Scenario 2: Service connectivity options”, Retrieved at << <http://www.ibm.com/developerworks/webservices/library/ar-arprac5/index.html> >>, Dec. 18, 2007, pp. 13.

Chatterjee, Soumen, “Messaging Patterns in Service-Oriented Architecture”, Retrieved at << [http://msdn.microsoft.com/en-us/library/aa480027.aspx#aj2mpsoarch\\_topic6](http://msdn.microsoft.com/en-us/library/aa480027.aspx#aj2mpsoarch_topic6) >>, Apr. 2004, pp. 17.

U.S. Official Action dated Dec. 4, 2013 in U.S. Appl. No. 12/906,144.

U.S. Official Action dated Nov. 7, 2013 in U.S. Appl. No. 13/764,887.

U.S. Official Action dated Jul. 23, 2013 in U.S. Appl. No. 12/906,144.

U.S. Official Action dated May 6, 2013 in U.S. Appl. No. 12/901,591.

U.S. Notice of Allowance dated Apr. 2, 2013 in U.S. Appl. No. 12/907,996.

U.S. Notice of Allowance dated May 21, 2014 in U.S. Appl. No. 12/901,591.

U.S. Notice of Allowance dated May 2, 2014 in U.S. Appl. No. 13/764,887.

\* cited by examiner

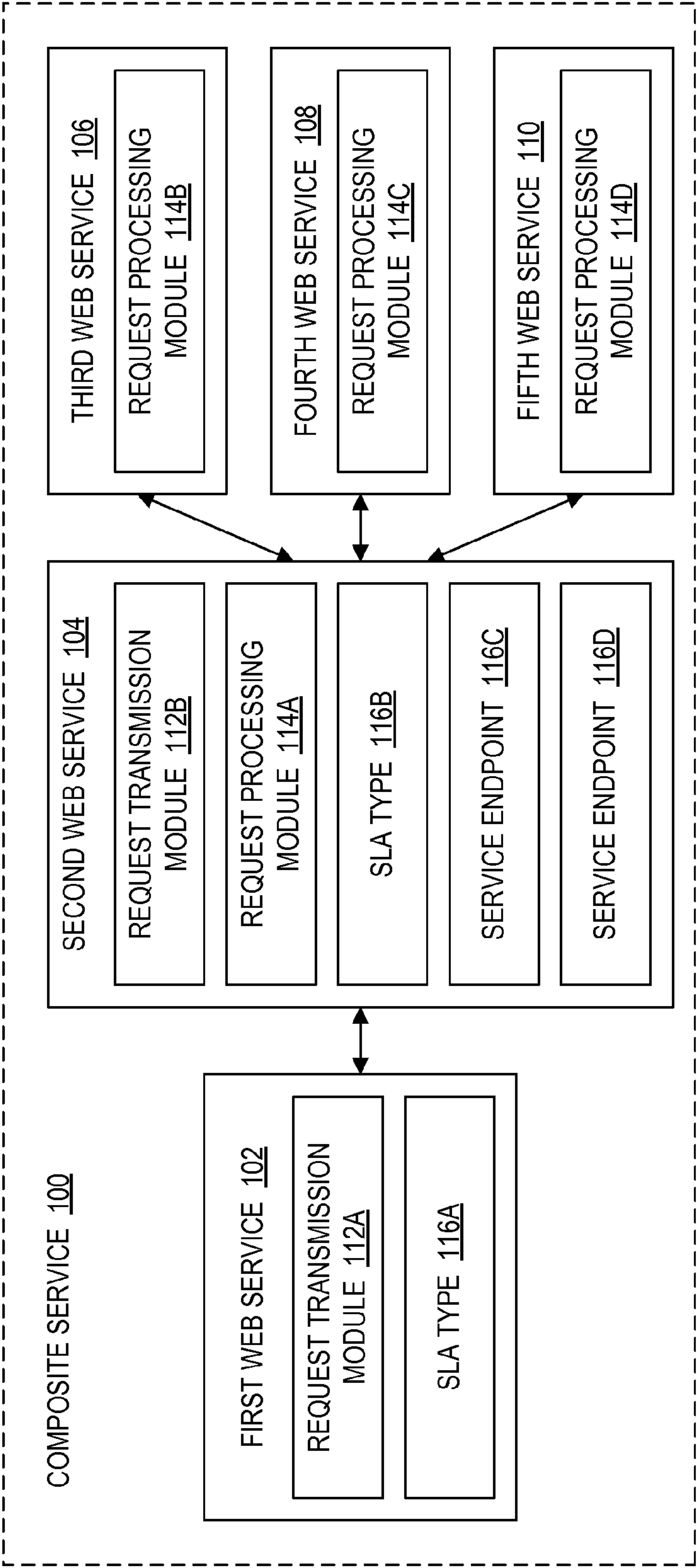
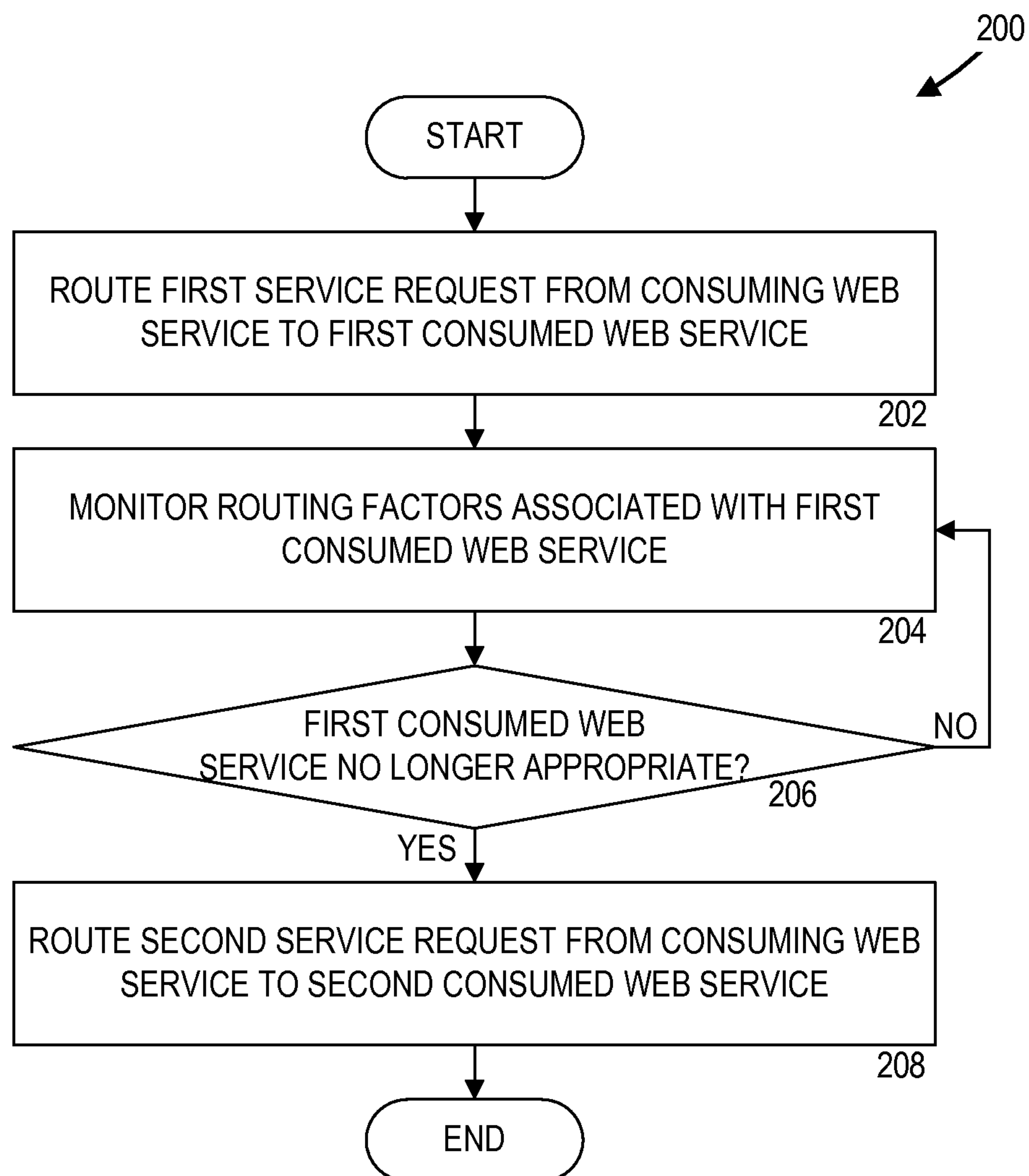


Fig. 1

*Fig. 2*

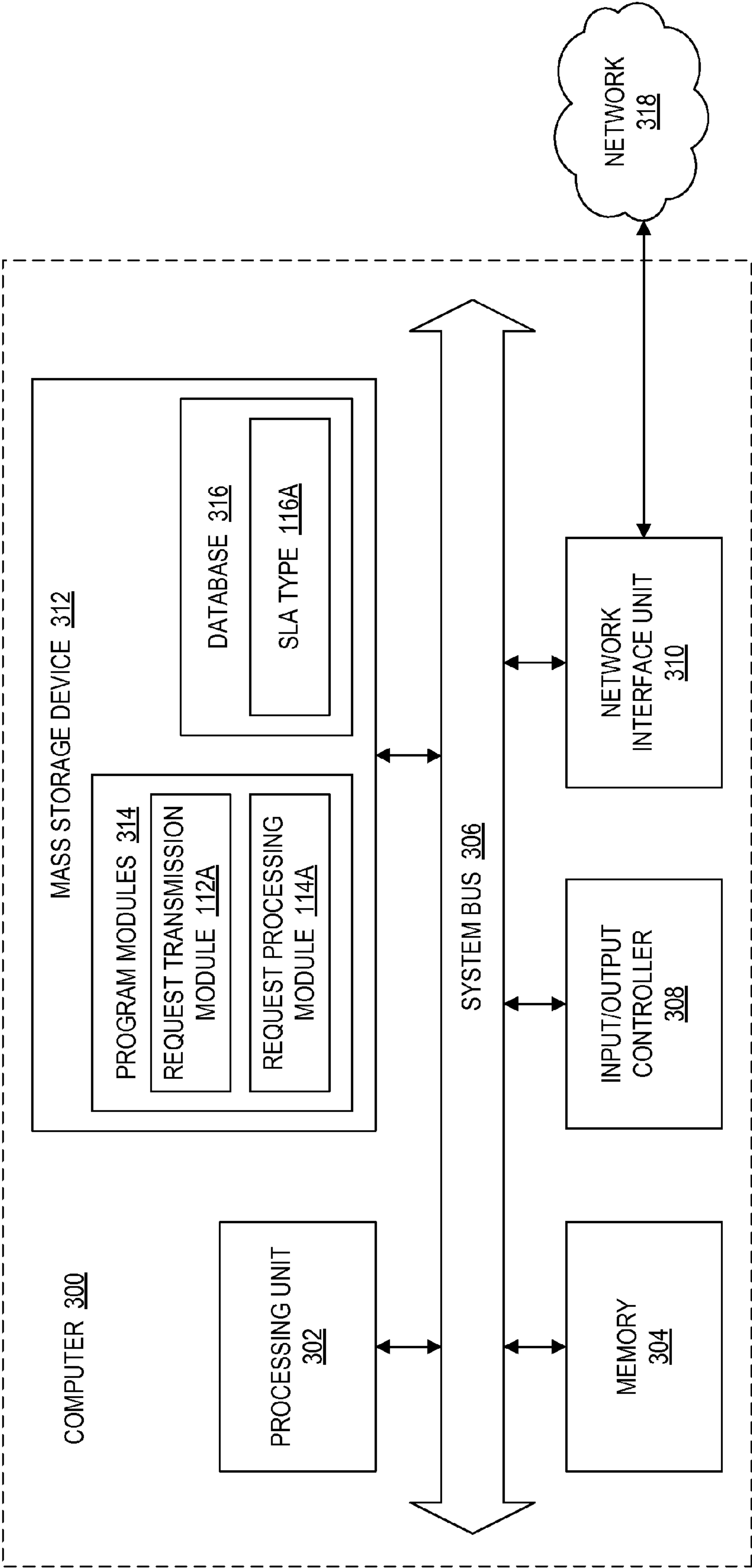


Fig. 3



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## OPTIMIZED CONSUMPTION OF THIRD-PARTY WEB SERVICES IN A COMPOSITE SERVICE

### BACKGROUND

Conventional software applications have generally been installed and executed in a localized computing environment, such as a desktop or enterprise environment. The advancement of increasingly powerful computing devices and expanding data storage capacity in large scale networked data centers has moved consumer and business-oriented applications away from local computing environments to computing environments provided over the Internet or other types of networks, commonly referred to as “cloud-based” computing environments. These applications may be offered as hosted services in the cloud-based computing environment.

As the Internet continues to grow, service providers may continue to offer more diverse hosted services. These hosted services may be offered at various levels, including end user services and various backend services. For example, a hosted service may offer one level of service to one hosted service and offer another level of service to another hosted service. The various levels of service may refer to different allocations of resources, such as processing resources, memory resources, networking resources, and/or the like. Combining these hosted services can yield a composite service. It is difficult, however, to integrate multiple levels of hosted services, especially when these hosted services are offered by different service providers.

It is with respect to these considerations and others that the disclosure made herein is presented.

### SUMMARY

Technologies are described herein for optimizing consumption of third party web services. A composite service may include multiple World Wide Web (“web”) services. Each web service may be a consuming service and/or a consumed service. A consuming web service may “consume” a consumed web service in that the consuming web service may route service requests to the consumed web service and utilize functionality provided by the consumed web service in response to the service requests. The service requests may include requests for information (e.g., retrieve requested information) and requests for action (e.g., perform requested action).

Through the utilization of the technologies and concepts presented herein, a consuming web service may be configured to optimize consumption of consumed web service services. The consumed web services may provide a common functionality, which is consumed by the consuming web service. The consuming web service and its corresponding consumed web services may be controlled and/or operated by different entities. The consuming web service may select one of the consumed services to route a service request based on various business rules adapted to reduce cost, increase efficiency, and endure continuity of service of the consuming web service. The consuming web service may then route the service request to the selected consumed service, which can respond to the service request. The business rules may guide the consuming service to selecting the consumed service based on various real-time or near real-time routing factors, such as service availability, variable pricing, a number of service requests handled, response times, and the like.

Example technologies may provide for routing a service request to an appropriate web service. The technologies route

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a first service request from a first web service to a second web service. The technologies monitor routing factors associated with the second web service. The technologies determine whether the routing factors indicate that the second web service is no longer appropriate for handling service requests. If the routing factors indicate that the first web service is no longer appropriate for handling service requests, then the technologies route a second service request from the first web service to a third web service. The first web service, the second web service, and the third web service are included a composite service.

It should be appreciated that the above-described subject matter may also be implemented as a computer-controlled apparatus, a computer process, a computing system, or as an article of manufacture such as a computer-readable storage medium. These and various other features will be apparent from a reading of the following Detailed Description and a review of the associated drawings.

This Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended that this Summary be used to limit the scope of the claimed subject matter. Furthermore, the claimed subject matter is not limited to implementations that solve any or all disadvantages noted in any part of this disclosure.

### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram illustrating a composite service adapted to route a service request to an appropriate web service, in accordance with some embodiments;

FIG. 2 is a flow diagram illustrating a method for routing a service request to an appropriate web service, in accordance with some embodiments; and

FIG. 3 is a computer architecture diagram showing an illustrative computer hardware architecture for a computing system capable of implementing the embodiments presented herein.

### DETAILED DESCRIPTION

The following detailed description is directed to technologies for optimizing consumption of third-party web services. A consuming web service may be configured to initially route service requests to a first consumed web service in accordance with a predetermined order. The consuming web service may monitor real-time or near real-time routing factors, such as service availability, variable pricing, a number of requests handled, and response times, associated with the consuming web service.

The consuming web service may evaluate the monitored routing factors according to business rules in order to determine whether the first consumed web service is no longer appropriate for responding to service requests. The business rules may be adapted to reduce cost, increase efficiency, and ensure continuity of service of the consuming web service. When the consuming web service determines that the first consumed web service is no longer appropriate for responding to service requests, the consuming web service may temporarily route service requests to a second consumed web service in accordance with the predetermined order. The consuming web service may continue to monitor routing factors of the currently utilized consumed web service and further route service requests to other consumed web services, as necessary, according to the predetermined order.



While the subject matter described herein is presented in the general context of program modules that execute in conjunction with the execution of an operating system and application programs on a computer system, those skilled in the art will recognize that other implementations may be performed in combination with other types of program modules. Generally, program modules include routines, programs, components, data structures, and other types of structures that perform particular tasks or implement particular abstract data types. Moreover, those skilled in the art will appreciate that the subject matter described herein may be practiced with other computer system configurations, including hand-held devices, multiprocessor systems, microprocessor-based or programmable consumer electronics, minicomputers, mainframe computers, and the like.

In the following detailed description, references are made to the accompanying drawings that form a part hereof, and which are shown by way of illustration, specific embodiments, or examples. Referring now to the drawings, in which like numerals represent like elements through the several figures, a computing system and methodology for optimizing consumption of third-party web services will be described.

FIG. 1 illustrates a composite service 100 adapted to route a service request to an appropriate web service, in accordance with some embodiments. The composite service 100 may include a first web service 102, a second web service 104, a third web service 106, a fourth web service 108, and a fifth web service 110. The web services 102-110 may be coupled via a communications network, such as the network 318 illustrated in FIG. 3. An example of the composite service 100 is the monitoring service described in U.S. patent application Ser. No. 12/900,481, filed Oct. 8, 2010, entitled "Providing a Monitoring Service in a Cloud-Based Computing Environment," which is hereby incorporated by reference in its entirety. Some examples of the web services 102-110 include the various web services (e.g., controller application, monitor application, finder application, analyzer application, notifier application, etc.) also described in the above referenced and incorporated patent application entitled "Providing a Monitoring Service in a Cloud-Based Environment."

The first web service 102 may include a request transmission module 112A and a SLA type 116A. The second web service 104 may include a request transmission module 112B, a request processing module 114A, and SLA types 116B-116D. The third web service 106 may include a request processing module 114B. The fourth web service 108 may include a request processing module 114C. The fifth web service 110 may include a request processing module 114D. The request transmission modules 112A-112B may be collectively referred to as request transmission modules 112. The request processing modules 114A-114D may be collectively referred to as request processing modules 114. The SLA types 116A-116D may be collectively referred to as SLA types 116.

According to various embodiments, a consuming web service may be configured to "consume" a consumed web service in that the consuming web service may request and utilize functionality provided by the consumed web service. In particular, the consuming web service may send a service request to the consumed web service. The consumed web service may then respond to the service request. If the service request is a request for information (e.g., a request for retrieve product information), then the consumed web service may respond to the service request by retrieving the requested information and sending the requested information to the consuming web service. If the service request is a request for an action (e.g., a request to notify a user), then the consumed

web service may respond to the service request by performing the action and sending an acknowledgement of the action to the consuming web service.

In the example illustrated in FIG. 1, the first web service 102 may consume the second web service 104. As a result, with respect to the first web service 102 and the second web service 104, the first web service 102 may be a consuming web service, and the second web service 104 may be a consumed web service. Further, the second web service 104 may consume the third web service 106, the fourth web service 108, and/or the fifth web service 110. As a result, with respect to the second web service 104, the third web service 106, the fourth web service 108, and the fifth web service 110, the second web service 104 may be a consuming web service, and the third web service 106, the fourth web service 108, and the fifth web service 110 may be consumed web services. The third web service 106, the fourth web service 108, and the fifth web service 110 may include similar or overlapping functionality adapted to respond to the service requests from the second web service 104.

According to various embodiments, the first web service 102 may be configured to transmit service requests to the second web service 104, which is configured to respond to the service requests. The level of service provided by the second web service 104 to the first web service 102 may be specified by the SLA type 116A. In order to respond to the service requests from the first web service 102, the second web service 104 may transmit additional service requests to the third web service 106, the fourth web service 108, and/or the fifth web service 110, which respond to the additional service requests. The levels of service provided by the third web service 106, the fourth web service 108, and the fifth web service 110 may be specified by the SLA types 116B-116D, respectively. A higher level of service may correspond to a greater allocation of resources, while a lower level of service may correspond to a lower allocation of resources. Such resources may include hardware, software, and/or networking resources.

The request transmission module 112B in the second web service 104 may be configured to initially route service requests to the request processing module 114B in the third web service 106. For example, the second web service 104 may utilize consumed web services in a specified order, and the third web service 106 may be the first listed web service in the specified order. The request transmission module 112B may also be configured to monitor various real-time or near real-time routing factors associated with the request processing module 114B in order to determine whether the third web service 106 is appropriate for responding to service requests. If the monitored routing factors indicate that the third web service 106 is no longer appropriate, then the first web service 102 may temporarily route service requests to other consumed web services, such as the fourth web service 108 or the fifth web service 110.

In a first embodiment, the monitored routing factors may indicate that the third web service 106 will be offline within a specified time frame. For example, the third web service 106 may broadcast a message specifying a time frame during which the third web service 106 will be unavailable for maintenance or upgrade. Further, the SLA type 116A may specify a minimum availability of service that the second web service 104 is desired or required to provide the first web service 102. In order to ensure this minimum availability of service, the request transmission module 112B in the second web service 104 may route service requests to the request processing module 114C in the fourth web service 108 during the speci-



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fied time frame. For example, the fourth web service **108** may be the second listed web service in the specified order.

When the request transmission module **112B** routes service requests to the fourth web service **108**, the request transmission module **112B** may monitor additional real-time or near real-time routing factors associated with the request processing module **114C** in order to determine whether the fourth web service **108** is appropriate for responding to service requests. If the monitored additional routing factors indicate that the fourth web service **108** is not available during at least part of the specified time frame, then the request transmission module **112B** may route the service requests to the request processing module **114D** in the fifth web service **110**. For example, the fifth web service **110** may be the third listed web service in the specified order. When the specified time frame passes, the request transmission module **112B** may route service requests back to the request processing module **114B**.

In a second embodiment, the monitored routing factors may indicate that the third web service **106** offers variable pricing at different times. That is, an operator of the second web service **104** may pay a different fee, depending on the time, to utilize the third web service **106**. For example, the third web service **106** may offer higher pricing during peak hours (e.g., business hours during a weekday) and lower pricing during off-peak hours. In this case, the request transmission module **112B** may route service requests to the request processing module **114C** and/or the request processing module **114D** during higher fee time periods where the fees for the fourth web service **108** and/or the fifth web service **110** are lower than the fees for the third web service **106**. Between the fourth web service **108** and the fifth web service **110**, the request transmission module **112B** may select the web service having the lowest fees during the higher fee time periods and/or based on other suitable criteria (e.g., bandwidth, availability, responsiveness, etc.). The request transmission module **112B** may route service requests back to the third web service **106** during lower fee time periods where the fees for the third web service **106** are lower than the fees for the fourth web service **108** and the fifth web service **110**.

In a third embodiment, the monitored routing factors may indicate that the third web service **106** can handle only a limited number of service requests per unit of time. For example, the SLA type **116B** between the second web service **104** and the third web service **106** may specify a first limit of service requests. When the first limit has been reached on the third web service **106**, the request transmission module **112B** may route service requests to the request processing module **114C** according to the specified order. The SLA **116C** type between the second web service **104** and the fourth web service **108** may specify a second limit of service requests. When the second limit has been reached on the fourth web service **108**, the request transmission module **112B** may route service requests to the request processing module **114D** according to the specified order. The second web service **104** may route service requests back to the request processing module **114B** when the first limit resets.

In a fourth embodiment, the monitored routing factors may indicate that the third web service **106** is non-responsive for a period of time. For example, response times for the third web service **106** may exceed a threshold that adversely affects whether the second web service **104** can meet responsiveness desires or requirements specified by the SLA type **116A**. In this case, the request transmission module **112B** may route service requests to the request processing module **114C** according to the specified order. The request transmission module **112B** may monitor additional real-time or near real-

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time routing factors associated with the request processing module **114C**. If monitored additional routing factors indicate that the fourth web service **108** is non-responsive within a period of time, then the request transmission module **112B** may route service requests to the request processing module **114D** according to the specified order. The request transmission module **112B** may route service requests back to the request processing module **114B** when it is found to be responsive. In other embodiments, the monitored routing factors may indicate any suitable criteria indicating changes in cost, efficiency, or continuity of service.

Referring now to FIG. 2, additional details regarding the operations of the request transmission modules **112** and the request processing modules **114** will be provided. In particular, FIG. 2 is a flow diagram illustrating a method for routing a service request to an appropriate web service, in accordance with some embodiments. It should be appreciated that the logical operations described herein are implemented (1) as a sequence of computer implemented acts or program modules running on a computing system and/or (2) as interconnected machine logic circuits or circuit modules within the computing system. The implementation is a matter of choice dependent on the performance and other requirements of the computing system. Accordingly, the logical operations described herein are referred to variously as states operations, structural devices, acts, or modules. These operations, structural devices, acts, and modules may be implemented in software, in firmware, in special purpose digital logic, and any combination thereof. It should be appreciated that more or fewer operations may be performed than shown in the figures and described herein. These operations may also be performed in a different order than those described herein.

In FIG. 2, a routine **200** begins at operation **202**, where a request transmission module, such as the request transmission module **112B**, routes a first service request from a consuming web service, such as the second web service **104**, to a first consumed web service, such as the third web service **106**. For example, the second web service **104** may be the first listed consumed web service in a specified order. The request processing module **114B** may receive the first service request and respond to the first service request. If the first service request is a request for information, the request processing module **114B** may respond to the first service request by retrieving the information and providing the information to the second web service **104**. If the first service request is a request for action, the request processing module **114B** may perform the action and provide an acknowledgement of the performance to the second web service **104**. When the request transmission module **112B** routes the first service request from the second web service **104** to the third web service **106**, the routine **200** may proceed to operation **204**.

At operation **204**, the request transmission module **112B** monitors routing factors associated with the third web service **106**. The routing factors may indicate whether the third web service **106** is no longer appropriate for handling service requests. The routing factors may be real-time or near real-time. In a first embodiment, the routing factors may include availability of the third web service **106**. For example, the third web service **106** may not be available or not operational during a particular time frame. In a second embodiment, the routing factors may include variable pricing of the third web service **106**. For example, the third web service **106** may charge a higher fee for service during peak hours and a lower fee for service during off-peak hours.

In a third embodiment, the routing factors may include a number of service requests handled by the third web service **106**. For example, the number of service requests handled by



the third web service **106** may exceed a threshold specified in the SLA type **116B** between the second web service **104** and the third web service **106**. In a fourth embodiment, the routing factors may include response times of the third web service **106** responding to previous service requests. For example, the response times may exceed a threshold that affects whether the second web service **104** can meet responsiveness expectations or requirements of the SLA type **116A** between the first web service **102** and the second web service **104**. In other embodiments, the monitor routing factors may indicate any suitable criteria indicating changes in cost, efficiency, or continuity of service. When the request transmission module **112B** monitors routing factors associated with the third web service **106**, the routine **200** may proceed to operation **206**.

At operation **206**, the request transmission module **112B** may determine whether the third web service **106** is no longer appropriate for handling service requests based on the routing factors. In a first embodiment, the request transmission module **112B** may determine that the third web service **106** is no longer appropriate for handling service requests during the particular time frame when the third web service **106** is not available. In a second embodiment, the request transmission module **112B** may determine that the third web service **106** is no longer appropriate for handling service requests during peak hours when the third web service **106** charges a higher fee.

In a third embodiment, the request transmission module **112B** may determine that the third web service **106** is no longer appropriate for handling service requests when the number of service requests handled by the third web service **106** exceeds the threshold specified in the SLA type **116B**. In a fourth embodiment, the request transmission module **112B** may determine that the third web service **106** is no longer appropriate for handling service requests when the response times of the third web service **106** exceeds a threshold that affects whether the second web service **104** can meet responsiveness expectations or requirements of the SLA type **116A**. In other embodiments, the request transmission module **112B** may determine that the third web service **106** is no longer appropriate for handling service requests when the routing factors indicate increases in cost, reductions in efficiency, and/or interruptions in continuity of service.

If the request transmission module **112B** determines that the third web service **106** is appropriate for handling service requests based on the routing factors, then the routine **200** may proceed back to operation **204**, where the request transmission module **112B** continues to monitor the routing factors associated with the third web service **106**. If the request transmission module **112B** determines that the third web service **106** is no longer appropriate for handling service requests based on the routing factors, then the routine **200** may proceed to operation **208**. At operation **208**, the request transmission module **112B** may route a second service request to the fourth web service **108**. For example, the fourth web service **108** may be the second listed web service in the specified order. The routine **200** may repeat (e.g., periodically, continuously, or on demand as needed) or terminate.

Turning now to FIG. 3, an example computer architecture diagram showing a computer **300** is illustrated. The computer **300** may include a central processing unit **302**, a system memory **304**, and a system bus **306** that couples the memory **304** to the **302**. The computer **300** may further include a mass storage device **312** for storing one or more program modules **314** and the database **316**. Examples of the program modules **314** may include the request transmission module **112A** and the request processing module **114A**. The database **316** may store relevant information for the SLA type **116A**. The mass

storage device **312** may be connected to the processing unit **302** through a mass storage controller (not shown) connected to the bus **306**. The mass storage device **312** and its associated computer-storage media may provide non-volatile storage for the computer **300**. Although the description of computer-storage media contained herein refers to a mass storage device, such as a hard disk or CD-ROM drive, it should be appreciated by those skilled in the art that computer-storage media can be any available computer storage media that can be accessed by the computer **300**.

By way of example, and not limitation, computer-storage media may include volatile and non-volatile, removable and non-removable media implemented in any method or technology for the non-transitory storage of information such as computer-storage instructions, data structures, program modules, or other data. For example, computer-storage media includes, but is not limited to, RAM, ROM, EPROM, EEPROM, flash memory or other solid state memory technology, CD-ROM, digital versatile disks ("DVD"), HD-DVD, BLU-RAY, or other optical storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other medium which can be used to store the desired information and which can be accessed by the computer **300**.

According to various embodiments, the computer **300** may operate in a networked environment using logical connections to remote computers through a network such as the network **318**. The computer **300** may connect to the network **318** through a network interface unit **310** connected to the bus **306**. It should be appreciated that the network interface unit **310** may also be utilized to connect to other types of networks and remote computer systems. The computer **300** may also include an input/output controller **308** for receiving and processing input from a number of input devices (not shown), including a keyboard, a mouse, a microphone, and a game controller. Similarly, the input/output controller **308** may provide output to a display or other type of output device (not shown).

The bus **306** may enable the processing unit **302** to read code and/or data to/from the mass storage device **312** or other computer-storage media. The computer-storage media may represent apparatus in the form of storage elements that are implemented using any suitable technology, including but not limited to semiconductors, magnetic materials, optics, or the like. The computer-storage media may represent memory components, whether characterized as RAM, ROM, flash, or other types of technology. The computer-storage media may also represent secondary storage, whether implemented as hard drives or otherwise. Hard drive implementations may be characterized as solid state, or may include rotating media storing magnetically-encoded information.

The program modules **314** may include software instructions that, when loaded into the processing unit **302** and executed, cause the computer **300** to route a service request to an appropriate web service. The program modules **314** may also provide various tools or techniques by which the computer **300** may participate within the overall systems or operating environments using the components, flows, and data structures discussed throughout this description. For example, the program modules **314** may implement interfaces for routing a service request to an appropriate web service.

In general, the program modules **314** may, when loaded into the processing unit **302** and executed, transform the processing unit **302** and the overall computer **300** from a general-purpose computing system into a special-purpose computing system customized to route a service request to an



appropriate web service. The processing unit **302** may be constructed from any number of transistors or other discrete circuit elements, which may individually or collectively assume any number of states. More specifically, the processing unit **302** may operate as a finite-state machine, in response to executable instructions contained within the program modules **314**. These computer-executable instructions may transform the processing unit **302** by specifying how the processing unit **302** transitions between states, thereby transforming the transistors or other discrete hardware elements constituting the processing unit **302**.

Encoding the program modules **314** may also transform the physical structure of the computer-storage media. The specific transformation of physical structure may depend on various factors, in different implementations of this description. Examples of such factors may include, but are not limited to: the technology used to implement the computer-storage media, whether the computer-storage media are characterized as primary or secondary storage, and the like. For example, if the computer-storage media are implemented as semiconductor-based memory, the program modules **314** may transform the physical state of the semiconductor memory, when the software is encoded therein. For example, the program modules **314** may transform the state of transistors, capacitors, or other discrete circuit elements constituting the semiconductor memory.

As another example, the computer-storage media may be implemented using magnetic or optical technology. In such implementations, the program modules **314** may transform the physical state of magnetic or optical media, when the software is encoded therein. These transformations may include altering the magnetic characteristics of particular locations within given magnetic media. These transformations may also include altering the physical features or characteristics of particular locations within given optical media, to change the optical characteristics of those locations. Other transformations of physical media are possible without departing from the scope of the present description, with the foregoing examples provided only to facilitate this discussion.

Based on the foregoing, it should be appreciated that technologies for routing a service request to an appropriate web service are presented herein. Although the subject matter presented herein has been described in language specific to computer structural features, methodological acts, and computer readable media, it is to be understood that the invention defined in the appended claims is not necessarily limited to the specific features, acts, or media described herein. Rather, the specific features, acts and mediums are disclosed as example forms of implementing the claims.

The subject matter described above is provided by way of illustration only and should not be construed as limiting. Various modifications and changes may be made to the subject matter described herein without following the example embodiments and applications illustrated and described, and without departing from the true spirit and scope of the present invention, which is set forth in the following claims.

What is claimed is:

**1.** A computer-implemented method for routing a service request to an appropriate web service, the method comprising computer-implemented operations for:

- routing a first service request from a first web service to a second web service, wherein the first web service consumes the second web service;
- monitoring routing factors associated with the second web service;

determining whether the routing factors indicate that the second web service is no longer appropriate for handling service requests;

in response to determining that the routing factors indicate that the second web service is no longer appropriate for handling service requests, routing a second service request from the first web service to a third web service, the first web service, the second web service, and the third web service in a composite service, wherein the second web service consumes the third web service;

monitoring additional routing factors associated with the third web service;

determining whether the additional routing factors indicate that the third web service is no longer appropriate for handling service requests; and

in response to determining that the additional routing factors indicate that the third web service is no longer appropriate for handling service requests, routing a third service request from the first web service to a fourth web service, the fourth web service in the composite service, wherein the second web service consumes the fourth web service.

**2.** The computer-implemented method of claim **1**, wherein monitoring routing factors associated with the second web service comprises monitoring service availability of the second web service; and

wherein determining whether the routing factors indicate that the second web service is no longer appropriate for handling service requests comprises determining whether the availability of the second web service indicates that the second web service is no longer appropriate for handling service requests.

**3.** The computer-implemented method of claim **2**, wherein determining whether the availability of the second web service indicates that the second web service is no longer appropriate for handling service requests comprises:

- identifying a time frame during which the second web service is not operational; and
- determining that the availability of the second web service indicates that the second web service is no longer appropriate for handling service requests during the time frame.

**4.** The computer-implemented method of claim **1**, wherein monitoring routing factors associated with the second web service comprises monitoring variable pricing of the second web service; and

wherein determining whether the routing factors indicate that the second web service is no longer appropriate for handling service requests comprises determining whether the variable pricing of the second web service indicates that the second web service is no longer appropriate for handling service requests.

**5.** The computer-implemented method of claim **4**, wherein determining whether the variable pricing of the second web service indicates that the second web service is no longer appropriate for handling service requests comprises:

- identifying a time frame during which the second web service charges a higher fee; and
- determining that the second web service is no longer appropriate for handling service requests during the time frame.

**6.** The computer-implemented method of claim **1**, wherein monitoring routing factors associated with the second web service comprises monitoring a number of service requests handled by the second web service; and

wherein determining whether the routing factors indicate that the second web service is no longer appropriate for



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handling service requests comprises determining whether the number of service requests indicates that the second web service is no longer appropriate for handling service requests.

7. The computer-implemented method of claim 6, wherein determining whether the number of service requests indicates that the second web service is no longer appropriate for handling service requests comprises:

determining that the number of service requests exceeds a threshold specified in a service level agreement between the first web service and the second web service; and upon determining that the number of service requests exceeds the threshold specified in the service level agreement between the first web service and the second web service, determining that the number of service requests indicates that the second web service is no longer appropriate for handling service requests.

8. The computer-implemented method of claim 1, wherein monitoring routing factors associated with the second web service comprises monitoring a response time of the second web service; and

wherein determining whether the routing factors indicate that the second web service is no longer appropriate for handling service requests comprises determining whether the response time of the second web service indicates that the second web service is no longer appropriate for handling service requests.

9. The computer-implemented method of claim 8, wherein determining whether the response time of the second web service indicates that the second web service is no longer appropriate for handling service requests comprises:

determining that the response time exceeds a threshold; and

upon determining that the response time exceeds a threshold, determining that the response time indicates that the second web service is no longer appropriate for handling service requests.

10. The computer-implemented method of claim 1, wherein the first service request comprises a request for information; and wherein the second web service is adapted to retrieve the information and provide the information to the second web service in response to the request.

11. The computer-implemented method of claim 1, wherein the first service request comprises a request to perform an action; and wherein the second web service is adapted to perform the action and provide an acknowledgment to the first web service in response to the request.

12. A computer system, comprising:

a processor;

a memory communicatively coupled to the processor; and a program module which executes in the processor from the memory and which, when executed by the processor, causes the computer system to route a service request to an appropriate web service by

routing a first service request from a first web service to a second web service, wherein the first web service consumes the second web service,

monitoring real-time or near real-time routing factors associated with the second web service,

determining whether the routing factors indicate that the second web service is no longer appropriate for handling service requests,

in response to determining that the routing factors indicate that the second web service is no longer appropriate for handling service requests, routing a second service request from the first web service to a third web service, the first web service, the second web

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service, and the third web service in a composite service, wherein the second web service consumes the third web service,

monitoring additional routing factors associated with the third web service,

determining whether the additional routing factors indicate that the third web service is no longer appropriate for handling service requests, and

in response to determining that the additional routing factors indicate that the third web service is no longer appropriate for handling service requests, routing a third service request from the first web service to a fourth web service, the fourth web service in the composite service, wherein the second web service consumes the fourth web service.

13. An optical disk, a magnetic disk storage device, or solid state storage device having computer-executable instructions stored thereon which, when executed by a computer, cause the computer to:

route a first service request from a first web service to a second web service, wherein the first web service consumes the second web service;

monitor routing factors associated with the second web service;

determine whether the routing factors indicate that the second web service is no longer appropriate for handling service requests;

in response to determining that the routing factors indicate that the second web service is no longer appropriate for handling service requests, route a second service request from the first web service to a third web service, wherein the second web service consumes the third web service, the first web service;

monitor additional routing factors associated with the third web service;

determine whether the additional routing factors indicate that the third web service is no longer appropriate for handling service requests; and

in response to determining that the additional routing factors indicate that the third web service is no longer appropriate for handling service requests, route a third service request from the first web service to a fourth web service, the first web service, the second web service, the third web service, and the fourth web service in a composite service, wherein the second web service consumes the fourth web service.

14. The computer system of claim 12, wherein monitoring routing factors associated with the second web service comprises monitoring variable pricing of the second web service; and

wherein determining whether the routing factors indicate that the second web service is no longer appropriate for handling service requests comprises determining whether the variable pricing of the second web service indicates that the second web service is no longer appropriate for handling service requests.

15. The computer system of claim 12, wherein monitoring routing factors associated with the second web service comprises monitoring a number of service requests handled by the second web service; and

wherein determining whether the routing factors indicate that the second web service is no longer appropriate for handling service requests comprises determining whether the number of service requests indicates that the second web service is no longer appropriate for handling service requests.



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**16.** The computer system of claim **12**, wherein monitoring routing factors associated with the second web service comprises monitoring a response time of the second web service; and

wherein determining whether the routing factors indicate  
that the second web service is no longer appropriate for  
handling service requests comprises determining  
whether the response time of the second web service  
indicates that the second web service is no longer appro-  
priate for handling service requests.

**17.** The computer system of claim **12**, wherein determining whether the routing factors indicate that the second web service is no longer appropriate for handling service requests comprises determining whether the routing factors indicate that the second web service is no longer appropriate for handling service requests based on business rules adapted to reduce cost, increase efficiency, and ensure continuity of service.

**18.** An optical disk, a magnetic disk storage device, or solid state storage device having computer-executable instructions stored thereon which, when executed by a computer, cause the computer to:

route a first service request from a first web service to a second web service, wherein the first web service consumes the second web service;

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monitor routing factors associated with the second web service;

determine whether the routing factors indicate that the second web service is no longer appropriate for handling service requests;

in response to determining that the routing factors indicate that the first web service is no longer appropriate for handling service requests, route a second service request from the first web service to a third web service, wherein the second web service consumes the third web service, the first web service;

monitor additional routing factors associated with the third web service;

determine whether the additional routing factors indicate that the third web service is no longer appropriate for handling service requests; and

in response to determining that the additional routing factors indicate that the third web service is no longer appropriate for handling service requests, route a third service request from the first web service to a fourth web service, the first web service, the second web service, the third web service, and the fourth web service in a composite service, wherein the second web service consumes the fourth web service.

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